What is claimed is:

1. An optical element for use in an adaptive-optical system, the optical element comprising:

a deformable optical surface;

an array of force devices coupled to the optical surface, each force device being configured, when actuated, to exert a respective force on a respective locus of the optical surface that imparts a respective localized deformation of the optical surface such that actuation of the force devices collectively forms the optical surface into a desired shape, the force devices being arranged into multiple sets, each force device being a member of a designated first set and a designated second set that is different from the first set;

at least one force controller coupled to the force devices of a respective first set and configured to cause, when activated, the force devices of the respective first set to apply respective forces to the respective loci; and

at least one braking controller coupled to the force devices of a respective second set and configured to prevent, when activated, a change in force exerted by the force devices of the respective second set and by at least one force device of the first set.

2. The optical element of claim 1, wherein:

each force device comprises a respective movable member;

the force controllers are configured to cause, when activated, the movable members of the force devices of the respective first set to apply respective forces to the respective loci; and

the at least one braking controller is configured to prevent, when activated, a change in force exerted by the movable members of the force devices of the respective second set and by the movable member of at least one force device of the first set.

3. The optical element of claim 1, wherein the first set and second set are arrayed rectilinearly with respect to each other.

4. The optical element of claim 3, wherein each force device comprises a respective movable member that is actuated and braked by a respective combination of a force controller and a braking controller that is unique for each force device.

5. The optical element of claim 3, comprising multiple first sets and multiple second sets of force devices, wherein each first set is actuated by a respective force controller and each second set is braked by a respective braking controller.

6. The optical element of claim 5, wherein:

each first set and each second set comprises multiple respective force devices; and

the number of force controllers is less than the number of force devices.

7. The optical element of claim 6, wherein the number of force controllers and braking controllers is less than the number of force devices.

8. The optical element of claim 1, wherein each force device comprises a respective piston situated in and movable with respect to a respective cylinder.

9. The optical element of claim 1, wherein each force device is electrically actuated.

10. The optical element of claim 1, wherein force device is hydraulically actuated.

11. The optical element of claim 1, wherein each force device is pneumatically actuated.

12. The optical element of claim 1, wherein each force device is magnetically braked by the respective braking controller.

13. The optical element of claim 11, wherein the respective braking controller applies a magnetic field to the force device, the magnetic field having a direction that is at a right angle to a force axis of the force device.

14. The optical element of claim 1, wherein the force devices are electrically braked by respective braking controllers.

15. The optical element of claim 1, wherein the force devices are hydraulically braked by the respective braking controllers.

16. The optical element of claim 1, wherein the force devices are pneumatically braked by the respective braking controllers.

17. The optical element of claim 1, configured as a mirror, wherein the deformable optical surface is a reflective surface of the mirror.

18. An optical apparatus, comprising:

a deformable optical surface;

a plurality of lockable force devices each arranged adjacent a respective localized portion of the deformable optical surface, each of the lockable force devices being included in a respective one of a plurality of braking groups and a respective one of a plurality of force-altering groups;

a plurality of braking controllers corresponding to the plurality of force-altering groups, respectively; and

a control system configured to control the plurality of braking controllers and the plurality of force controllers to control the plurality of lockable force devices so as selectively to deform the deformable optical surface to a desired shape.

19. The apparatus of claim 18, wherein the plurality of lockable force devices is controlled by the control system, the braking controllers, and the force controllers to impart respective localized forces onto the deformable optical surface.

20. The apparatus of claim 18, wherein each of the braking controllers is configured to control a locking state of the lockable force devices in a corresponding lock group.

21. The apparatus of claim 18, wherein each of the force controllers is configured to control the respective localized forces imparted onto the deformable optical surface by the lockable force devices in the corresponding force-altering group.

22. The apparatus of claim 18, wherein the control system is further configured to direct at least one of the force controllers to set a force applied to respective localized portions of the deformable optical surface by of the lockable force devices in the corresponding force-altering group.

23. The apparatus of claim 18, wherein the control system is further configured to (i) direct at least one of the braking controllers to unlock the lockable force devices in the corresponding braking group for each force device in the corresponding braking group, and (ii) direct the at least one braking controller to re-lock the lockable force devices in the corresponding braking group after the lockable force devices are imparting a desired force onto the deformable optical surface.

24. The apparatus of claim 18, wherein the control system is further configured to (i) direct the force controllers to set respective forces applied to the respective localized portions of the deformable optical surface by the lockable force devices, and (ii) direct the braking controllers to lock the lockable force devices to selectively deform the deformable optical surface to the desired shape.

25. The apparatus of claim 24, wherein the control system directs the force controllers to set respective forces applied to the respective localized portions of the deformable optical surface by the lockable force devices one force-altering group at a time.

26. The apparatus of claim 24, wherein the control system directs the braking controllers to lock respective forces applied to the respective portions of the deformable optical surface by the lockable force devices one braking group at a time.

27. An adaptive-optical element, comprising:

a deformable optical surface;

an array of force devices coupled to the optical surface and configured to exert respective forces on the optical surface that impart respective localized deformations of the optical surface so as collectively to form the optical surface into a desired shape, the force devices being arranged into rows and columns, each force device being a member of a designated row and a designated column;

at least one force controller coupled to the force devices of a respective column and configured to cause the force devices of the respective column to apply respective forces to respective loci of the optical surface so as to deform the optical surface; and

at least one braking controller coupled to the force devices of a respective row and configured to prevent, when the at least one braking controller is activated, a change in the respective forces applied by the respective force devices of the respective row.

28. The optical element of claim 27, further comprising:

a sensor configured to detect and measure an optical characteristic of the optical surface; and

an array controller coupled to the sensor, to the at least one force controller, and to the at least one braking controller of the array, the array controller being configured to determine a desired shape of the optical surface based on measurement data

concerning the optical surface obtained by the sensor and to adjust the at least one force controller and at least one braking controller of the array in order to achieve the desired shape.

29. The optical element of claim 27, wherein the array comprises fewer force controllers than force devices.

30. The optical element of claim 27, wherein the at least one braking controller comprises a magnetic brake.

31. The optical element of claim 30, wherein:

each force device comprises a respective movable member coupled to a respective locus of the optical surface, the movable member being configured to exert a respective force on the respective locus; and

the array further comprises an array body, wherein the movable members of the array are disposed in and configured to move relative to respective bores defined in the array body.

32. The optical element of claim 31, wherein the magnetic brake comprises:

a magnetic-flux pathway extending through at least a subset of the force devices in the respective row and through at least a respective portion of the array body; and

a magnetic-field source magnetically coupled to the pathway and configured to create, when energized, a magnetic field within the pathway.

33. The optical element of claim 32, wherein the magnetic field produced by the magnetic-field source creates a magnetic force sufficient to arrest movement of the respective movable members of the force devices in the pathway.

34. The optical element of claim 33, wherein the magnetic-field source is a solenoid.

35. The optical element of claim 33, wherein the magnetic-field source is a permanent magnet.

36. The optical element of claim 37, wherein the at least one braking controller comprises a pneumatically actuated brake.

37. The optical element of claim 27, wherein the at least one braking controller comprises a cam-actuated brake.

38. The optical element of claim 27, configured as a mirror, wherein the deformable optical surface is a reflective surface of the mirror.

39. An optical system, comprising an adaptive-optical element, the adaptive-optical element comprising:

a deformable optical surface;

an array of force devices coupled to the optical surface, each force device comprising a respective movable member that is configured, when actuated, to exert a respective force on a respective locus of the optical surface that imparts a respective localized deformation of the optical surface such that actuation of the force devices collectively forms the optical surface into a desired shape, the force devices being arranged into multiple sets, each force device being a member of a designated first set and a designated second set that is different from the first set;

at least one force controller coupled to the force devices of a respective first set and configured to cause, when activated, the movable members of the force devices of the respective first set to apply respective forces to the respective loci; and

at least one braking controller coupled to the force devices of a respective second set and configured to prevent, when activated, a change in force exerted by the movable members of the force devices of the respective second set and by the movable member of at least one force device of the first set.

40. A lithographic exposure system, comprising an optical system as recited in claim 39.

41. The lithographic exposure system of claim 40, configured for using a beam of extreme ultraviolet light as a lithographic exposure light.

42. An optical system, comprising an adaptive-optical element, the adaptive-optical element comprising:

a deformable optical surface;

an array of force devices coupled to the optical surface and configured to exert respective forces on the optical surface that impart respective localized deformations of the optical surface so as collectively to form the optical surface into a desired shape, the force devices being arranged into rows and columns, each force device being a member of a designated row and a designated column;

at least one force controller coupled to the force devices of a respective column and configured to cause the force devices of the respective column to apply respective forces to respective loci of the optical surface so as to deform the optical surface; and

at least one braking controller coupled to the force devices of a respective row and configured to prevent, when the at least one braking controller is activated, a change in the respective forces applied by the respective force devices of the respective row.

43. A lithographic exposure system, comprising an optical system as recited in claim 42.

44. An optical system, comprising an adaptive-optical element, the adaptive-optical element comprising:

a deformable optical surface;

an array of force devices coupled to the optical surface and configured to exert respective forces on the optical surface that impart respective localized deformations of

the optical surface so as collectively to form the optical surface into a desired shape, the force devices being arranged into braking groups and force-altering groups, each force device being a member of a designated braking group and a designated force-altering group;

at least one force controller coupled to the force devices of a respective force-altering group and configured to cause the force devices of the respective force-altering group to apply respective forces to respective loci of the optical surface so as to deform the optical surface; and

at least one braking controller coupled to the force devices of a respective braking group and configured to prevent, when activated, a change in the respective forces applied by the respective force devices of the respective braking group when the braking controller is activated.

45. A lithographic exposure system, comprising an optical system as recited in claim 44.

46. The lithographic exposure system of claim 45, configured for using a beam of extreme ultraviolet light as a lithographic exposure light.

47. An adaptive-optical element, comprising:

a deformable reflective surface;

a plurality of force devices coupled to respective loci associated with the reflective surface;

a force controller coupled to a first set of the force devices and configured to adjust respective forces exerted by the force devices in the first set to the respective loci; and

a braking controller coupled to a second set of the force devices and configured to activate a braking mechanism that prevents a change in the forces exerted by the force devices in the second set.

48. The adaptive-optical element of claim 47, wherein each of the force devices is coupled to a respective force controller and a respective braking controller.

49. The adaptive-optical element of claim 48, wherein each of the force devices is coupled to a unique combination of respective force controller and respective braking controller.

50. The adaptive-optical element of claim 47, comprising a number of force controllers that is less than a number of force devices.

51. The adaptive-optical element of claim 47, wherein:

the braking mechanism is a magnetic brake; and

the force devices of at least a subset of the second set each comprise a magnetizable material.

52. The adaptive-optical element of claim 51, wherein the magnetizable material is iron.

53. The adaptive optical element of claim 51, wherein the magnetic brake is activated by a magnetic-field source.

54. The adaptive-optical element of claim 53, wherein the magnetic-field source is a solenoid or permanent magnet.

55. The adaptive-optical element of claim 47, wherein the braking mechanism comprises at least one pneumatically actuated piston configured to exert a force substantially normal to respective operational axes of the force devices of the second set.

56. The adaptive-optical element of claim 47, wherein the braking mechanism comprises at least one cam-actuated piston configured to exert a force substantially normal to respective operational axes of the force devices of the second set.

57. The adaptive-optical element of claim 47, wherein:

each of the force devices comprises a respective bellows configured to be pressurized with a fluid; and

the force controller comprises a valve configured to pressurize the bellows of the force devices of the first set.

58. The adaptive-optical element of claim 47, wherein the force controller comprises a cam that is operably coupled to the force devices of the first set.

59. An adaptive-optical system, comprising an adaptive-optical element as recited in claim 47.

60. A lithographic exposure system, comprising an adaptive-optical system as recited in claim 59.

61. The lithographic exposure system of claim 60, configured to perform lithography using a beam of extreme ultraviolet light.

62. A force device for an adaptive-optical element having a deformable optical surface, the force device comprising:

a movable member coupled to a respective locus of the deformable optical surface, the movable member comprising a first magnetizable portion formed from a magnetizable material; and

a unit of material surrounding the movable member, the unit of material defining an operational axis along which the movable member moves relative to the unit of

material whenever the movable member is actuated, the unit of material including at least a second magnetizable portion formed from the magnetizable material,

wherein the magnetizable portions of the movable member and of the unit of material collectively form a magnetic-flux pathway that is substantially normal to the operational axis.

63. The force device of claim 62, wherein the unit of material is configured as a sleeve for the movable member.

64. The force device of claim 62, further comprising a magnetic-field source configured to create a magnetic field in the magnetic-flux pathway.

65. The force device of claim 64, wherein the magnetic-field source is a permanent magnet.

66. The force device of claim 64, wherein the magnetic-field source is a solenoid.

67. The force device of claim 64, wherein the magnetizable material exhibits a hysteresis sufficient to maintain the magnetic field in the magnetic-flux pathway after deactivation of the magnetic-field source.

68. The force device of claim 62, wherein:

the movable member is configured as a piston; and

the unit of material is configured as a cylinder in which the piston is movable along the operational axis.

69. The force device of claim 62, further comprising a pressurizable bellows coupled to the movable member.

70. The force device of claim 62, further comprising a magnetic-flux return path magnetically coupled with the magnetic-flux pathway so as to define a magnetic-flux circuit.

71. The force device of claim 70, wherein the magnetic-flux return path comprises a magnetizable plug.

72. The force device of claim 62, wherein the magnetizable material is iron.

73. An adaptive-optical element, comprising;

a deformable optical surface; and

at least one force device, as recited in claim 62, contacting a respective locus of the optical surface.

74. An adaptive-optical system, comprising an adaptive-optical element as recited in claim 73.

75. A lithographic exposure system, comprising an adaptive-optical system as recited in claim 74.

76. The lithographic exposure system of claim 75, configured to perform a lithographic exposure using a beam of extreme ultraviolet light.

77. A method for adjusting a deformable optical surface of an adaptive-optical element, the method comprising:

coupling multiple force devices to respective loci of the deformable optical surface, each force device comprising a respective movable member that is configured, when actuated, to exert a respective force on the respective locus of the optical surface that imparts a respective localized deformation of the optical surface such that actuation of the force devices collectively forms the optical surface into a desired shape, the force

devices being arranged into multiple sets configured to be individually actuated and individually braked;

unlocking a set of force devices;

actuating the force devices in the set so as to adjust the respective forces exerted on the optical surface by the force devices in the set; and

braking the force devices in the set to prevent changes in the respective forces exerted on the optical surface by the force devices in the set.

78. The method of claim 77, wherein the unlocking and braking steps are performed using a single braking controller for the set.

79. The method of claim 77, further comprising the step of adjusting the respective forces exerted on the optical surface by the force devices in the set to a previous force profile before unlocking the set of force devices.

80. The method of claim 77, further comprising the step of selecting the set of force devices to unlock and actuate.

81. The method of claim 80, wherein the selecting step is performed taking into consideration a detected optical characteristic of the optical surface.

82. The method of claim 77, wherein the step of unlocking the set of force devices comprises deactivating a magnetic brake coupled to the force devices in the set.

83. The method of claim 82, wherein the step of deactivating the magnetic brake comprises moving a permanent magnet or de-energizing a solenoid associated with the magnetic brake.

84. A lithographic exposure method, comprising:

passing a beam of lithographic exposure light through an optical system comprising at least one adaptive-optical element including multiple force devices coupled to respective loci of a deformable optical surface of the adaptive-optical element, each force device comprising a respective movable member that is configured, when actuated, to exert a respective force on the respective locus of the optical surface that imparts a respective localized deformation of the optical surface such that actuation of the force devices collectively forms the optical surface into a desired shape, the force devices being arranged into multiple sets;

unlocking a set of the force devices;

actuating the force devices in the set so as to adjust the respective forces exerted on the optical surface by the force devices in the set;

braking the force devices in the set to prevent changes in the respective forces exerted on the optical surface by the force devices in the set;

repeating the steps of unlocking, actuating, and braking for other sets as required so as to provide the beam of lithographic exposure light with a corrected optical characteristic; and

performing lithography of a substrate using the corrected beam.

85. The method of claim 84, further comprising the step of sensing light from the adaptive-optical element to obtain data concerning the optical characteristic, wherein the steps of actuating and braking are performed in response to the data.

86. A method for adjusting a deformable optical surface of an adaptive-optical element, the method comprising:

coupling a set of multiple force devices to respective loci of the deformable optical surface, each force device comprising a respective movable member that is configured, when actuated, to exert a respective force on the respective locus that

imparts a respective localized deformation of the optical surface such that actuation of the force devices collectively forms the optical surface into a desired shape;

coupling the force devices in the set to force controllers such that at least one force device is coupled to a respective force controller;

energizing the force controllers so as to impart adjustments, as required, of the respective forces applied to the optical surface by the force devices of the set so as to establish a desired shape of the optical surface; and

locking the set of force devices by inducing a magnetic field that interacts with the movable members of at least a subset of the force devices of the set.

87. The method of claim 86, further comprising the step of unlocking the set of force devices, by deactivating the magnetic field, preparatory to energizing the force controllers.

88. The method of claim 87, further comprising the step of adjusting the forces, exerted on the optical surface by the force devices in the set, to previous respective levels before unlocking the set of force devices.

89. The method of claim 87, further comprising the steps of:

coupling multiple sets of force devices to respective loci of the deformable optical surface; and

selecting a particular set of force devices for the steps of energizing and locking.

90. The method of claim 89, wherein the selecting step is performed in response to data concerning a detected optical characteristic of the deformable optical surface.

91. The method of claim 87, wherein the magnetic field is induced by placement of a permanent magnet or energization of a solenoid.

92. A lithographic exposure method, comprising:

passing a beam of lithographic exposure light through an optical system comprising at least one adaptive-optical element including a set of multiple force devices coupled to respective loci of the deformable optical surface, each force device being configured, when actuated, to exert a respective force on the respective locus that imparts a respective localized deformation of the optical surface such that actuation of the force devices collectively forms the optical surface into a desired shape, the force devices in the set being coupled to force controllers such that at least one force device is coupled to a respective force controller;

energizing the force controllers so as to impart adjustments, as required, of the respective forces applied to the optical surface by the force devices of the set so as to establish a desired shape of the optical surface as required to achieve a desired corrected optical characteristic of the beam;

locking the set of force devices by inducing a magnetic field that interacts with the movable members of at least a subset of the force devices of the set; and

performing lithography of a substrate using the corrected beam.

93. The method of claim 92, further comprising the step of sensing light from the adaptive-optical element to obtain data concerning the optical characteristic, wherein the steps of actuating and braking are performed in response to the data.